Ideal Diode Controller or ORing Controller gate voltage is lower

RELATED PRODUCTS: LM74700-Q1, LM7480-Q1, LM7481-Q1, LM5050-1, LM5050-2, LM5051, TPS2410 and TPS2412

Question:

Gate voltage of Ideal Diode Controller or ORing Controller is low and the MOSFET is not fully enhanced.

Background:

Ideal Diode Controllers and ORing Controllers control the external N-Channel MOSFET in three different modes of operation as shown in Figure 9.

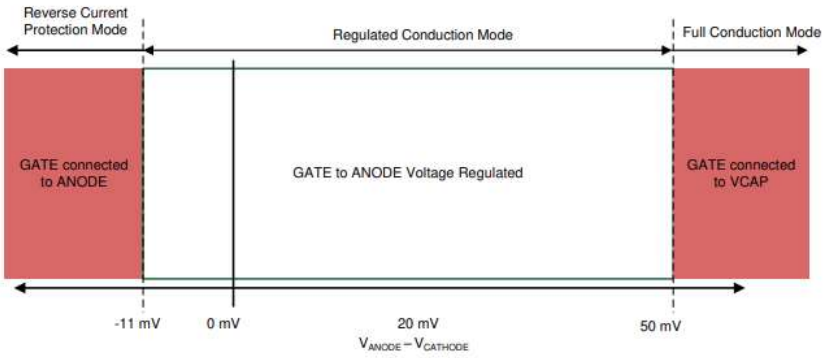

Figure 9: Gate Drive Modes of Ideal Diode Controller LM74700-Q1

During normal operation, controllers operate in regulated conduction mode or full conduction mode. In regulated conduction model, the linear regulation scheme maintains a very low forward voltage across the MOSFET source-drain. LM74700-Q1 regulates the forward drop across the MOSFET to 20mV (typical). LM5050-x and LM5051 regulated forward drop is 22mV (typical) and TPS2410/12 regulates to 10mV forward drop. Note that at higher load current, controller moves into full conduction mode and the MOSFET is fully enhanced.

Answer:

In linear regulation control, forward voltage of the MOSFET is regulated by controlling the gate voltage based on the load current. To be more precise, to regulate the forward voltage, the gate drive of the controller varies $R_{DS\,(ON)}$ of the MOSFET by controlling the V_{GS} of the MOSFET.

Linear Regulation Scheme:

- *IN-OUT > regulated forward voltage, increase V_{GS} gate voltage, reduce $R_{DS\,(ON)}$ of MOSFET*

- *IN-OUT < regulated forward voltage, reduce V_{GS} gate voltage, increase $R_{DS\ (ON)}$ of MOSFET*
- *IN-OUT > full conduction threshold, fully enhance the MOSFET with V_{GS} gate voltage >10V*
- *IN-OUT < reverse turn off threshold, turn off MOSFET by pulling GATE to SOURCE V_{GS} = 0V.*

Let us take LM74700-Q1 for illustration of the linear regulation scheme. LM74700-Q1's regulated forward voltage is 20mV, full conduction threshold is 50mV and reverse turn off threshold is -11mV.

Forward transfer characteristic, i.e., V_{GS} vs $R_{DS\ (ON)}$ of MOSFET DMT6007LFG is shown in Figure 10. At a nominal current of 3A, to regulate source-drain voltage to 20mV, controller need to maintain $R_{DS\ (ON)}$ = 20mV/3A = 6.67mΩ. From the forward transfer characteristic, $R_{DS\ (ON)}$ 6.67mΩ corresponds to V_{GS} 4V and hence the controller regulates the V_{GS} to 4V at 3A as shown in Figure 11.

Next, at 1A load current, the controller need to maintain $R_{DS\ (ON)}$ = 20mV/1A = 20mΩ. $R_{DS\ (ON)}$ 20mΩ corresponds to V_{GS} 3V and hence the controller regulates the V_{GS} to 3V at 1A as shown in Figure 12. Lastly, at high load current 5A, the controller need to maintain $R_{DS\ (ON)}$ = 20mV/5A = 4mΩ. $R_{DS\ (ON)}$ 4mΩ corresponds to V_{GS} >10V and hence the controller fully enhances the MOSFET with V_{GS} to 11V as shown in Figure 13.

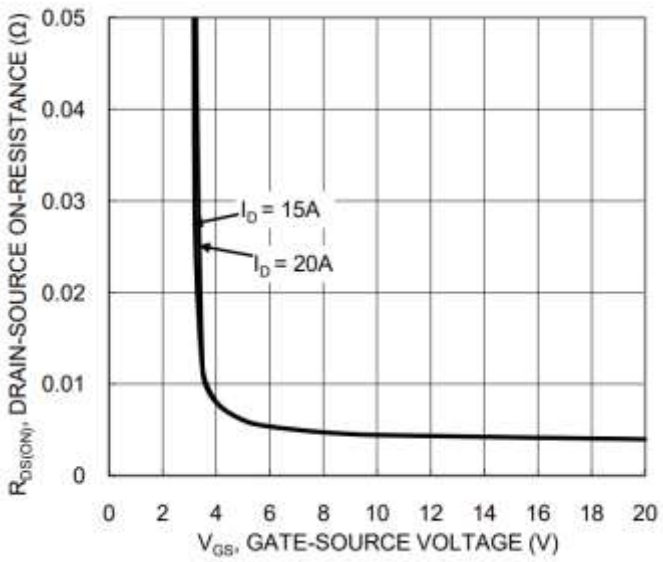

Figure 10: Forward Transfer Characteristic of MOSFET DMT6007LFG Datasheet

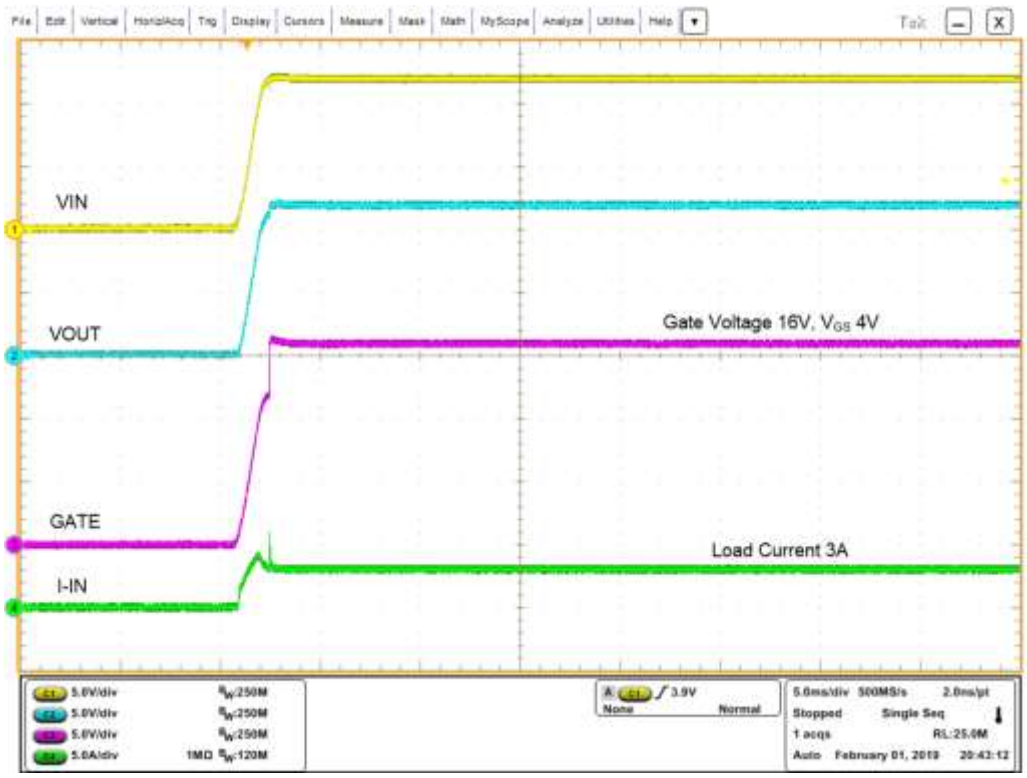

Figure 11: LM74700-Q1 driving DMT6007LFG at 3A Load Current

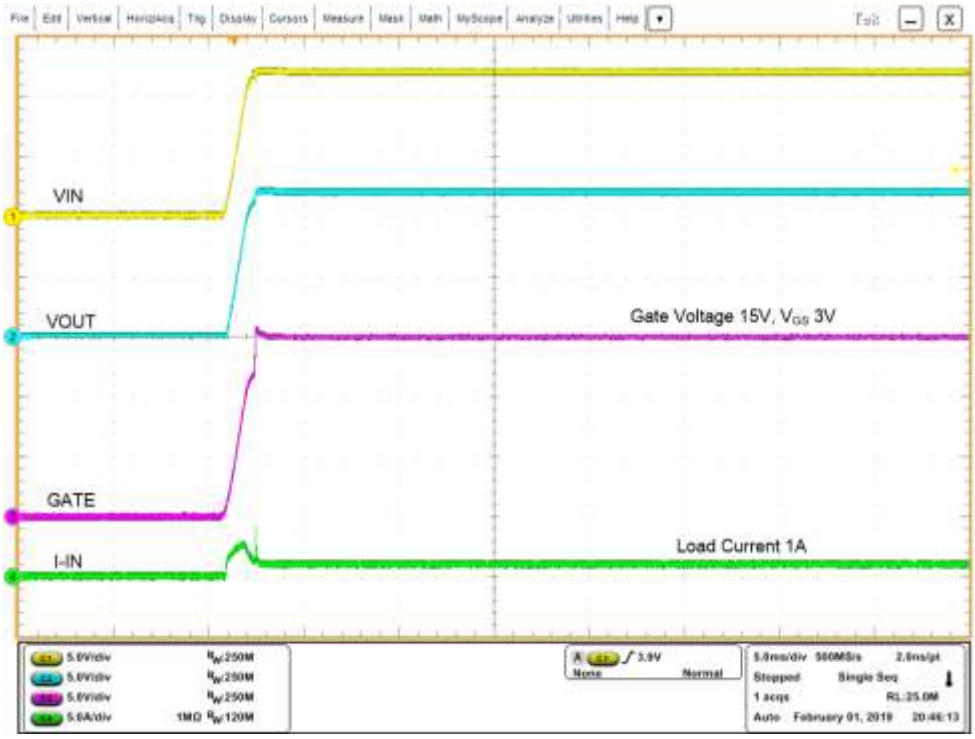

Figure 12: LM74700-Q1 driving DMT6007LFG at 1A Load Current.

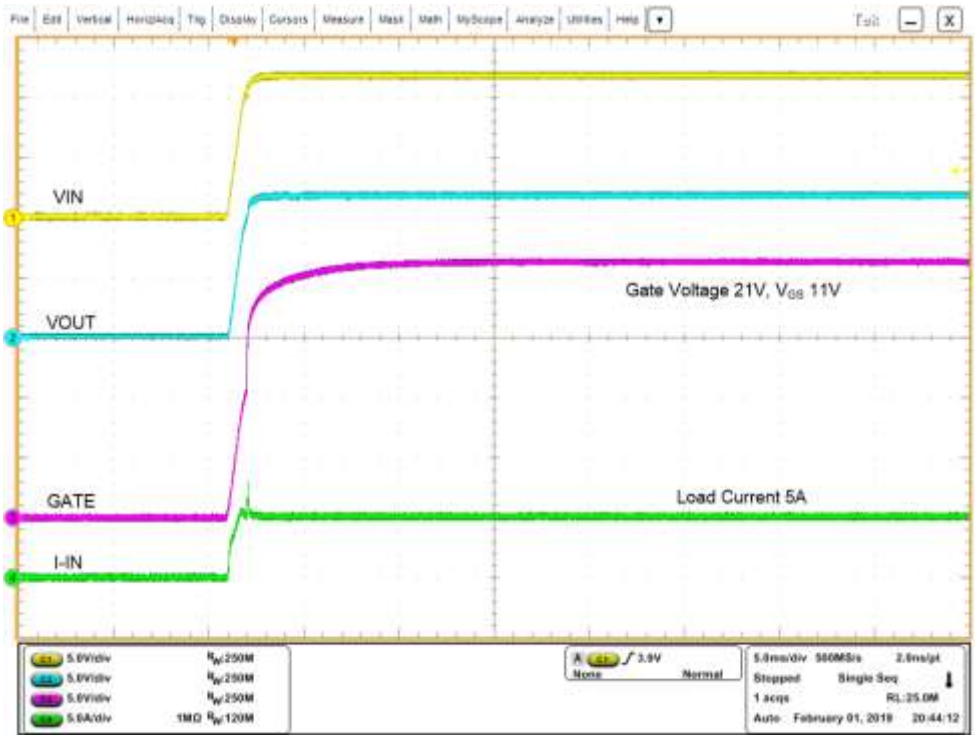

Figure 13: LM74700-Q1 driving DMT6007LFG at 5A Load Current

REFERENCE: APPLICATION NOTE ON Basics of Ideal Diode Controllers